Cellulose, Starch and Glycogen

A VALUABLE article on recent work on cellulose, starch and glycogen, by Prof. H. Staudinger, has appeared in a recent issue of *Die Naturwissenschaften* (**25**, 673; 1937). The fact that cellulose, starch and glycogen can be converted into esters without altering the degree of polymerization, and can be reconverted into the original substances, as shown by molecular weight determinations, optical rotation and other properties, shows that the glucose residues in the colloidal particles of these substances are linked by principal valencies. The colloidal particles are therefore macro-molecules. The determination of the molecular weights of these substances is discussed. The ebullioscopic and cryoscopic methods are difficult to apply owing to the smallness of the effect, and other anomalies; but molecular weights can be satisfactorily determined from osmotic pressure data using the equation of Schulz, or by Svedberg's method using the ultra-centrifuge. It is also possible to determine them from viscosity data by an equation due to Staudinger. All these methods agree in giving a value about 200,000 for the molecular weight.

X-ray analysis shows the molecule of solid cellulose to be extended, and there is reason for believing that this is also the case in solution. Viscosity determinations show, however, that in starch there is a bending back of the molecules. Starch molecules are only about one eighth as long as they should be if extended. With glycogen, solutions of the same concentration have the same viscosity, no matter what the degree of polymerization. This points to the existence of spherical macromolecules in this case. The linking of the glucose residues in these three compounds is discussed, and the connexion between physical properties and the shape of the molecule is emphasized.

Colloidal particles can be classified into two groups, linear and spherical colloids, according to the shape of the particles. The latter are powders in the solid state, and dissolve in water without swelling to give solutions of low viscosity. Linear colloids, on the other hand, are tough, fibrous substances, which dissolve with considerable swelling, and form viscous solutions. Glycogen is a typical spherical colloid, and its physical properties are not greatly altered by change in the size of the molecule. Cellulose is a typical linear colloid, and the physical properties depend a good deal on the size of the molecule. Starch occupies a position intermediate between cellulose and glycogen. A similar difference in structure of the macro-molecules is found in the case of the albumens.

The form of the macro-molecule of polysaccharides and albumens decides the different functions of these substances in the living organism. Cellulose forms the solid portions, whereas substances which have to be transported through the organism are spherical colloids.

Twenty-one Years of Glass Technology

THE subject of the presidential address delivered to the Society of Glass Technology at its twenty-first anniversary meeting at Sheffield by Prof. W. E. S. Turner was "Twenty-one Years. A Professor Looks Out on the Glass Industry". This address has now been published (Society of Glass Technology, Sheffield. Pp. 70+46 tables. 10*s.*; postage 3*d.*). Whilst its introductory and short concluding chapters are concerned mainly with the growth and development of the Society of Glass Technology and its international relationships, the major portion is occupied with an account of the great advances, mechanical, chemical and physical, which have revolutionized the ancient craft of glass-making throughout the world. The volume is one for the student of social history and of commerce as well as for those interested in the advances of applied science.

That the development of the completely automatic machine has been the dominant factor in influencing conditions in the industry during the period under review is brought out clearly by means of a carefully collected mass of evidence. The tendency to mechanization was already evident before 1916, as, for example, in the Owens' bottle machine which was brought to a commercial stage in the early years of the century, and by 1914 was in operation in ten European countries as well as in the United States. But its use was limited to a small number of licensees, and similar conditions prevailed with the few machines available in other sections of the industry.

During the intervening years, mechanical progress has been very rapid, and there are now in wide use seven or eight different types of bottle machine, as well as automatic machines for the manufacture of tumblers and other domestic ware, plate and sheet glass, electric lamp bulbs and tubing. The change has led to an enormous increase of productive power, as is evidenced, for example, by a growth of the annual output of containers in Great Britain between the years 1924 and 1935 by sixty-two per cent, or to take a still more striking example, of an increase of machine-made electric lamp-bulbs in Europe from $2\frac{1}{2}$ millions in 1919 to 127 millions in 1932.

Concurrently with the advance of the machine has been the steady disappearance of the skilled glass-blower, for a single bottle machine may equal the output of more than fifty men, and, to take an extreme case, the most modern lamp-bulb machine, the Corning 399, has produced more than 500,000 bulbs daily, equivalent to the production of 500 glass-blowers. The same tendency has not been at work in other branches of labour, for there is evidence even of a slight improvement in total employment in the industry, due to the great increase of sales of glassware, largely induced by the cheapening of production, for which the machine has been primarily responsible.